**1I No wall (Mollicutes):** smallest microbe, passes through 0.45 micron filters, 1/5 genome of *E.Coli.* Triple cell membrane with sterols (*Mycoplasma (3), Ureaplasma)*

1. *Mycop. Pneumoniae* [1-3 weeks]: respiratory droplets//aerobic/ fastidious. Atypical Pneumo
2. *Mycop. hominis/genitalium*: T-strain/PID/Postpartum fever
3. *Ureaplasma*: T-strain/urethritis (20% of cases), cervicitis, endometritis, PID, pyelonephritis

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**II Spirochetes:** nontoxic, highly invasive, damage is mediated by the immune response. Super long and super thin… thus they will need dark field microscopy to be seen. These are unique because they have endoflagella that are inadequate for locomotion in aqueous solution but fantastic for dense tissue. They could be considered a derivative of a g(-) because they have two membranes and a cell wall. However, they do not have LPS or lipotechoic acid and have few outer membrane proteins (only a few porins and lipoproteins).MANY LIPOPROTEINS on the inner membrane (*Borrelia (4 kinds) Leptospirosis(200 serotypes), Treponema)*

1. *Borrelia burgdorferi* (days to weeks): complement inhibition by Erp/Mg
2. *Secondary Borrelia burgdorferi*/ arthritis/neuro/cardiac response to lipoprotein.
3. *Borrelia hermsii/duttoni:* endemic relapsing fever
4. *Borrelia recurrentis:* epidemic relapsing fever, has a higher fatality rate **VMP**
5. *Leptospirosis:* (Weil’s Disease) or Severe Pulmonary Hemorrhagic Syndrome (SPHS).
6. *Treponema (10-90 days):* No lab growth. Tromps, lipo, host evasion by mimickry
7. *Congenital Treponema:* mother is the reservoir with transplacental infection.

**III Gram Positive: Rod (sporulating/non), Coccus, Pleomorphic, Actinomycete**

**🚑 Rods:**

*Mycobacteria*: Non sporulating hydrophobic barrier made of mycolic acids (acid fast stain), cause tubercles in the lung, non-motile, obligate aerobes. Slow growth, L-J media or Middlebrook’s media (Note that leprae cannt be cultured). Can survive weeks/months on inanimate objects. Resist freezing or drying but not UV or heating

1. *M.leprae(20yr latency):* droplet transmission and armidilos can carry
2. *M.avium and M.intracellulare:* MAC in the lungs
3. *M.marinum/M.ulcerans:*
4. *M.tuberculosis*: macrophages to bind to Fc, CR, Mannose receptor. IFN gamma.
   1. NOTE: LAM inhibit phago/lyso fusion.
   2. Mycolic acids barrier from UV, dessication and compliment/neutralizing antibodies.
   3. TDM cord glycolipid interferes with phagosome mat; damages mito/neutro
   4. 19 lipoprotein suppresses TNF-a, IL12, MHCII; apoptosis in late stage of infection
   5. PDIM peripheral lipid that is shed (like LAM) to interfere with MHCII loading.
5. *Listeria monocytogens:* can grow at 4C, listeriolysin, Otoxin, placental spread
6. *Bacillus antracis:* Fac anaerobe. Prominent protein capsule of poly-D glutamic acid.pOX1/2 INOCULATION/INJESTION/ INHILATION: macrophages circ and widening of the aortic arch
7. *Bacillus cereus:* aerobic or anaerobic Short/Long incubation and Occular infection
8. *Clostridium botulinum*: Strict anaerobeInfant /Wound /Food /Iatrogenic botulism
9. *Clostridium tetani (3-21 day incubation):* Tetanolysin/Tetanopasmin; anaerobic/retrograde Localized /Cephalic /Generalized tetanus:
10. *Clostridium perfringens:* Alpha toxin /Beta toxin /Epsilon toxin

food poisoning / Necrotic enterotoxin /Cellulitis/ Gas Gangrene (myonecrosis)

1. *Clostridium Difficile:* Toxin A (enterotoxin) chemotactic /cytotoxicity. Toxin B (cytotoxin)

**🚑** **Coccus**

*Streptococcus :* some secrete toxins others are non-toxin producing. Classified based on hemolysis (alpha beta gamma), group specific carbs (lancefield groups), biochemical characteristics (catalases…). Alpha create green colonies since they can lyse the cells but cannt take up the iron. Beta induce complete hemolysis. Gamma have not observable hemolysis.

1. *S.pyogenes-* M protein (distal block comp, proximal binds factor H) hyaluronic acid capusule pyrogenic exotoxins and super antigens to stimulate t cells.
   1. Scarlet Fever: toxin mediated (Exotoxins Spe A,C super antigens and B protease)
   2. Impetigo/Pyoderma
   3. Erysipelas: clear margin
   4. Cellulitis: no clear margin
   5. Necrotising Fasciitis: **Virulence: Hyaluronidase, M protein, Hemolysins O and S.**
   6. Staph Toxic Shock Syndrome: A and C are though tot mediate the pathogenesis.
   7. Randoms: Pneumonia, Puerpural Sepsis Lymphangitis
   8. Acute Rheumatic Fever (1-4 wks): poly arthritis (large joints), carditis, chorea, erythema marginatum, subcutaneous nodules, and MAYBE fever, arthralgia, acute phase reaction, increased sedimentation rate, CRP.
   9. Post strep Glomerulonephritis (1-4 wks): i complexes accumulate in the glomeruli.
2. *S.agalactiae-* bacitracin resistant but beta hemolytic. Also display sialic acid (mimicry). CytolysinE pore forming toxin causes tissue damage and bacterial spread by killing neutrophils. **Virulence:** binding, invade epithelial cells (even Brain), direct cell injury, resist phago/intracellular killing, activate inflammation, CNS neutrophil recruitment.
3. *S.pneumoniae:* MOST DAMAGE IS HOST IMMUNE RESPONSE **Virulence: Pneumolysin /**IgA Protease /Neuramidase and Hyaluronidase /Capsule is antiphagocytic. Also soluble capsular fragments are released to recruit neutrophils to increase inflammation. Autolysin / choline binding proteins /surface proteins to inhibit complement deposition.
4. *Enterococcus faecalis/faecium:* alpha hemolytic or non hemolytic. HIGH GENETIC TRANSFER

*Staphylococci:* Micrococcae family, catalase producing, facultative anaerobes. Some produce coagulase (CPS) and some do not (CoNS). In general, CPS are beta hemolytic, CoNS are gamma hemolytic. Typically seen in clusters (tetrad) on an agar plate. They are non-motile, non-spore forming but they do make exotoxin.

1. *Staph aureus:* carotenoids. PG, teichoic acid, protein A, Hemolysin, hyaluronidase, B-lactamase, exfoliates (scalled skin syndrome) cytotoxins are some key enzymes. SUPER ANTIGETNS: TSST1 and enterotoxins A-E bind and activate
   1. *Food poisoning:* [2-6 hrs] with enterotoxin A or B in foods left at room temp.
   2. *Toxic Shock Syndrome:* colonization leads to toxin production
   3. *Folliculitis:* inflammation leads to furuncles then carbuncles then hiradenitis
   4. *Impetigo:* see previous descriptions except crust is clear
   5. *Cellulitis:* see previous descriptions
   6. *Lymphagitis:* see previous descriptions
   7. *Scalled Skin Syndrome:* different **from TEN**
2. *MRSA:* toxin on a mobile phage (PFGE with rare cutting restriction enzymes)
3. *Staph epidermis:* contaminate “hardware”; biofilm protects from opsonization, antibiotic penetration and some of the surface antigens will promote its adherence.
4. *Staph hemolyticus:* resident in the skin and mucosal membranes. Everything similar to epidermis
5. *Staph saprophyticus:* similar UTI presentation as GNRs like E.coli.
6. *Staph lugdunensis:* aggressive CoNS but beta hemolytic ; PYR and rapid ornithine decarbxlase.

**🚑** **Pleomorphic: Coryneform bacteria (corynebacterium (6types), arcanobacterium, brevibacterium, rothia, tropheryma) and Propionibacteria**

1. *C. diptherieae (2-5 days):* facultative anaerobe, non-motile, mycolic acids, Metachromic granules
   1. Gravis
   2. Mitis: often with diphtheria and can acquire the prophage with the toxin
   3. Intermedium
   4. Belfanti: rarely seen in diphtheria

Ttoxin (lysogenic phage) B binds heparin-binding epidermal growth factor on host cells. A inactivates EF-2.

1. *C. jeikeium:*  opportunistic (hema disorders and IV catheters).
2. *C. urelyticum:* Urease, lives in renal stones and struvite calculi.
3. *C. amycolatum:* opportunistic in skin but not oropharynx #1 isolate in clinical specimens.
4. *C.* *ulcerans:* can carry the diphtheria toxin gene and indistinguishable from *C.diphtheria.*
5. *Pshedotuberculosis:* rarely carries the toxin gene.
6. *Arcanobacterium:* pharyngitis, wounds, endocarditis, septicemia.
7. *Brevibacterium:* cheese like odor; septicemia, osteomyelitis, foreign body infections.
8. *Rothia mucilaginosa:* Clusters in URT, cocci but corneform; mucoid = endocarditis. Bacteremia, endopthalmitis, catheter infections, CNS infections, pneumonia, peritonitis and septicemia.
9. *Tropheryma whippeli:* Disordered immune response to persistent bacteria. Infect macrophages. Cause heart, lung, brain, joint, eye disease. Fatal after 1 year. **OFTEN RELASES.**
10. *Propionibacterium acnes:* chains/clumps; anaerobic/aerotolerant; ferment

**🚑 Actinomycetes: g(+) bacteria with filamentous growth. An individual member is called an actinomycete. There are three basic groups: Actinomyces, Nocardia, Streptomyces. Some produce medium chain mycolic acids with a beading pattern in gram stains and are partially acid fast. Others have no mycolic acids and are normal g(+) gram staining.**

1. *Actinomyces israelii, naeslundii, radingae, turicensis (2 weeks)* endogenous infections. Molar tooth. Cervicofacial, thoracic, Farmer’s lung hypesensitivity (type III). Acute/subacute/chronic.
2. *Nocardia asteroids/brasiliensis (3-5 days):* external contaminant with medium chain mycolic acid. Culture looks like a fungal hyphae. Pulmonary, brain abcesses (30% of cases) &mycetomas infections (mycetoma in the feet). Virulence cord factor to prevent lysosomal/phagosomal fusion; prevents acidification of phagolysosome, protected by catalase and SOD, avoids phosphatase mediated killing.

**IV Gram Negative: Rod (aerobic/non), Coccus, Pleomorphic, Helical/Curved**

**🚑 Rod**

1. *Legionella:* special media to be cultured, inhibition of the mucociliary elevators; attacks alveolar macrophages Metaloproteases breaks down the lung tissue and destroys CD4 and IL2 receptors
2. *Enterobactericeae:* facultative aerobes. Motile (except shigella, klebsiella, Yersinia), fermenting bacteria classified by their serotypes. Major types are based on their H (flagella), K (capsule), O (surface LPS) proteins.
   1. *E.coli K1:* K1 capsule binds factor H and polysialic acid (like Neisseria)mimics NCAM; PMN cells in early replication (OmpA causes cells to increase the gp96 on PMN)
   2. *(UPEC)Uropathogenic (UPEC):* Type 1 pili for adhesion, pyelonephritis pili (PAP or P-fimbriae) Siderophores, alpha hemolysin (modulate inflammatory and trigger apop).
   3. *(EPEC) Enteropathogenic:* No inflammation or fever; bind via fimbrial adhesin and tightly bind via intimin (OMP which binds to Tir)
   4. *(EHEC) Enterohemorrhagic:* filaments and pilus; (O157:H7); acid resistant like shigella. Hemolytic-uremic syndrome HUS (10% of cases) mediated by the shiga-like endotoxin. #1 cause of acute renal failure in children. Food, swimming pools and animal contact.
   5. *Proteus mirabilis:* hyperflaggelated/urease-producing; degrade urea for N. calcium/carb deposists are a byproduct and are infected with the bug.
   6. *Klebsiella pneumonia:* K1 sero; Mucoid, non-motile, lactose fermenting and have urease. Capsule is the major virulence factor LPS causes sepsis, adhesins and siderophores.
   7. *Yersinia pestis:* Non-Outer proteins (Yop) block phago, reseal host membrane, block platelet activation. Silent for 1st 36hrs suppressing the immune system (increasing the risk of 2ndary infections) before activating a strong inflammatory response
   8. *Yersinia entercolitica:*  directly damage peyer’s patches; bacteremia by spread to the mesenteric lymph node. No siderophores so use a coinfecting bacteria. Can grow at 4C
   9. *Salmonella:* Non typhoidal salmonella and typhoid fever. Acid sensitive, pass into the blood, multiply in the macrophages of the liver and lymph nodes. Secondary bacteremia causes daily fevers for 4-8 weeks. Infected individuals:
      1. Carriers
      2. Gastroenteritis: *S.enterica* causing N/V/D (from chicken)
      3. Vascular endothelial infection: *S. choleraesuis, typhimurium*
      4. Typhoid fever: *S.typhi* and *paratyphi AandB (*human carrier)
      5. Particular ogan infection: *S.typhimurium* causing osteomyelitis in sickle cell
   10. *Shigella dysenteriae(1-7 days):* Acid stable; four serotypes (A-D) and A w/neuro complications (40% kids) due to shiga toxin (halts 60S ribosome
3. *Psuedomonas aeruginosa:* fimbrae, alginate (glycocalix), pyocyanin (impair human cilia), LPS. Exoenzyme S takes proteins while Exotoxin A inhibits EF2.
4. *Burkholderia mallei:* causes glanders and is a very close relative of psuedomonas
5. *Burkholderia pseudomallei:*  causes melliogosis
6. *Burkholderia cepacea:* same disease as *P.aeruginosa*; more pathogenic in CF patients

**🚑 Coccus: Neisseriaceae has Neisseria, Eikenella (opportunistic after fist fights/human bites), Kingella (normal inhabitant that can cause arthritis/endocarditis). Moraxella is the other group.**

1. *N.gonorrhoeae:*  IV pilus that lets them bind to CD46 on non-ciliated epithelium. Opa proteins to promote binding , PG fragments to kill the ciliated cells, Por proteins to facilitated infusion of epithelial cells, interfere with neutrophils and resistance to compement. LOS as endotoxin, IgA protease, complement evasion with factor H and also hide in neutrophils.
2. *N.meningitidis (3-4days):* Reservoir= human nasopharynx; virulence is due to the capsule which is resistant to phagocytosis, complement, intracellular killing and sialic acid (mimicry)
3. *Moraxella catarrhalis:*  human specific, diplococcic, oxidase positive, non-encapsulated, seen in PMNs. 15-20% of Otitis media and 30% of bacterial exacerbation of COPD.

**🚑 Pleomorphic rods**

1. *Rickettsiaceae:* resides in endothelial cells), stains poorly due to thin PG layer; animal and arthropod reservoirs. Enocytosis (OmpA) and phospholipase; ABM.
   1. *R.rickettsii (5-10 days after a 48hr tick bite):*  “Rocky Mountain Spotted Fever” dog ticks
   2. *R.akari(1-2 weeks): “*rickettsialpox”, human mite, urban areas; Lower morbidity
   3. *R.prowazekii (1-2 wks):* “epidemic typhus” higher mortality, recurrence, no ABM, louse
   4. *R.typhi (1-3 weeks): “*Endemic/murine typhus” fleas or rat louse. Black eschar
2. *Coxiella burnetii (LONG TIME with potential for chronic):* “query fever”, ticks. SCV: spore-like; LCV: metabolically active and replicating. Chronic =**Phase I (smooth) LPS w/ IgG;** acute =**Phase II (rough) LPS w/ IgM.**

🚑 **Curved/Helical**

1. *Heliobacter pylori:* Urease, flagella, mucinase, adhesins, SOD, catalase, immunogenic LPS, VacA (inhibit Tcell prolif and Ag present). Damage= ammonia, VacA, NAP, CagA
2. *Camplobacter jejuni (2-5 days):* #1 cause of bacterial gastroenteritis (CDT) is a DNAase, capsule, LOS provides immune evasion and tissue damage
3. *Vibrio cholera (2-4days):* O1 and O139 serotypes with ctxAB genes regulating the endotoxin. Neuramidase change GM1 increases toxin binding. Zot and Ace are the toxins responsible for a less severe diarrhea in other ctx- strains. VERY acid sensitive so need to have large numbers.
4. *Vibrio parahaemolyticus:* #1 cause of seafood gastroenteritis. Hemolysin is responsible for the chloride secretion and tissue damage
5. *Virbrio vulnificus:* #1 cause of seafood related deaths. Cytolysin/hemolysin cause the pores in eukaryotic cells leading to tissue damage. RtxA toxin is a cytotoxin. Capsule=necrotizing fasc.

**🚑 Chlamydiaceae:** unique family of g (-) which do not have PG (have disulfide linked envB) and are incredibly small. They do still have PBP but can’t be gram stained or given B-lactams. They are obligate intracellular (used to think they were viruses) and can’t really make their own ATP. Unique development in that they have EB elementary bodies (spore like) and RB reticulate bodies. EB is small, electron dense nucleoid and highly crosslinked EnvB. Glycosaminoglycan on host allows to bind, become endocytised and germinate to the RB. The RB is non-infectious, metabolically active and replicating by binary fission. EB -> RB -> EBs (72hrs). These show high rates of reinfection with little antibody protection.

1. *Chlamydia trachomatis:*  two forms are Thrachoma and LGV.
   1. Trachoma A-C causes conjunctivitis.
   2. Trachoma D-K causes the “clam” (STD) Reiter’s Syndrome “pee,see,tree”
   3. LGV painless ulcers in Africa/SA and mostly in homosexual men.
2. *Clamydophila psittaci (1-2 wks):* contracted by inhaling bird feces.
3. *Clamydophila pneumoniae (TWAR):* can have walking pneumonia; atherosclerosis link?